



# Remove Anything from Metal

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## TOOLS:

- [Drill \(1\)](#)
- [Tinsnips \(1\)](#)
- [Wire brush \(1\)](#)
- [Wire cutters \(1\)](#)



## PARTS:

- [Bucket \(1\)](#)
- [Sodium carbonate \(1\)](#)  
*[Used for fabric dyeing and adjusting pH. it's available from craft, aquarium, and home improvement stores. I paid \\$6 for a 2lb jar of Balance Pak 200 at a pool supply shop.](#)*
- [Rods \(4\)](#)  
*[for the anodes. Carbon rods last much longer. Do not use stainless, chrome, or galvanized steel, which will leach out toxic chromate.](#)*
- [Gutter leaf guards \(3\)](#)
- [Rod \(1\)](#)
- [Washer \(1\)](#)
- [Rod butt joint \(1\)](#)
- [Ceiling hook \(1\)](#)
- [Nut \(1\)](#)
- [Battery charger \(1\)](#)  
*[If your charger's ammeter doesn't go up](#)*

or its hum doesn't increase when you dip your part into the bath, you may need an older, "dumber" charger without a safety interlock, that won't test whether it's connected to a battery.

- [Wire \(1\)](#)
- [Zip ties \(30-50\)](#)
- [Water \(1\)](#)
- [Solder \(1\)](#)

for soft-clamp anode connection

## SUMMARY


I love using old machine parts for my projects; often their workmanship surpasses that of anything new, and you can get them cheap or even free. Find a junkyard full of ancient, rusty industrial equipment, and you can build almost anything — or at least be inspired to, which is half the battle!

But many older machine parts, especially cheap ones, have rust, paint, or other coverings that make them ugly and difficult to work with. Over the years, my salvage habit has turned me into something of an expert in amateur metal restoration. I am by no means a metalsmith, but I have collected a library of easy techniques that can enable any moderately equipped hobbyist to turn neglected lumps of metal into shiny, working components.

Rust, the oxidation of iron, takes up far more volume than the metal it grows from, so the parts underneath look surprisingly undamaged after treatment. The same goes for old paint, which protects the surfaces underneath it.

There are 3 basic ways to remove oxidation or paint from metal in a home shop: mechanical, chemical, and electrochemical. (Thermal methods, and exotic techniques like dry ice blasting, molten salt dips, and bacterial siderophores, require specialized equipment.) Here I describe some home methods, and how to construct one of the most effective rust-removal tools of all: an electrolytic conversion tank.

## Step 1 — Use mechanical methods.

- These work well for smooth surfaces with paint or other coatings, and some light rust. For surfaces with cracks, pits, or fine texture, the only effective mechanical method is abrasive blasting (aka sandblasting). But to get into the cracks, you can also follow other mechanical methods with chemical methods.
- Safety first: In the shop, I almost always **wear leather gloves**. A minor slip with a 12,000rpm wire brush will lead to a discouragingly wasted day at the emergency room. 
- **I wear goggles** 100% of the time that I'm working with any type of tool or liquid. It's easier to just leave them on rather than trying to remember, do I have them/where are they/do I need them for this task?
- Some of the chemicals used here have nasty fumes, so don't use more than you need, and **use chemicals outdoors**, where there is less risk of fume buildup.
- **Keep a fire extinguisher handy**, in case sparks or other heat sources cause flames. A related hint: Do not grind surfaces that are still wet with flammable cleaning liquid. Learn from my mistakes!
- **Wear respiratory protection** when using mechanical methods.

## Step 2

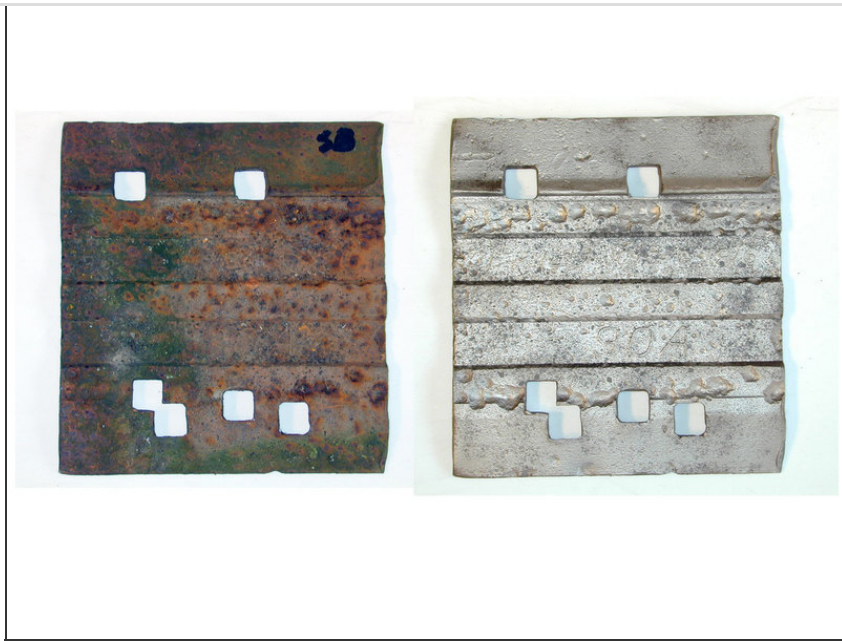
- **Sandpaper** Use on smooth, painted surfaces in good condition with no corrosion. Good for preserving delicate metal.
  - Start with heavy grits (80) and work down to a finer grit (200). Always sand wet — submerged or under a constant stream of water — to prevent the paper from clogging.
- **Steel wool** Removes superficial “flash” rust, surface imperfections, powder coats, and some thinner paint layers. Very fine wool (#000) will also remove stains from chrome and even windshield glass without noticeable scratching (but experiment first).
- **Scouring or sanding pads (manual)** Remove organic residues such as grease or oil buildup on engines, or sticker or tape gunk (use with solvent). Good for mild to medium surface rust in some cases.
  - 3M scouring pads are the only good ones I’ve found.
- **Scouring pad discs (powered)** At 13,000rpm, these discs are darn near miraculous against paint and light rust on any large, smooth surface.
  - Use scouring pads rather than sanding pads, which will sand away the metal itself. A die grinder will spin them faster and work better than a drill. 3M makes effective Roloc brand pads for die grinders. You can also try my hack of attaching a cutout rectangle of manual scouring pad to the bottom of an orbital sander in place of paper, which works wet or dry for cleaning boats, awnings, outdoor furniture, etc.

### Step 3



- **Angle grinder with wire cup brush** A low-cost, fast way to clean rust, paint, or other coatings from reasonably wide-open surfaces on large parts (see photo).
  - Will gouge aluminum and other soft metals and leave swirl marks on most steel. Very noisy and dusty, and wires can fly off and embed into arms, legs, etc. Less effective alternatives: drill with a wire brush bit, bench-mount wire brush grinder.
- **Angle grinder with flap wheel** Reduces thick paint buildup or heavy rust over large, flat areas. Best as an initial prep step. Removes everything rapidly, including the metal itself, so be careful!
- **Wire brush (manual)** Removes petrified grease from vehicle parts. Helps remove loose or powdered oxidation alongside other, more effective methods (second photo).
- **Needle scalers** These earsplitting devices have an array of thin, hard rods that successively slam forward a few millimeters with each stroke. They are effective at removing rust and paint, but care must be taken when used on thin or soft metal. The metal can be dented or pitted by the needles. They are usually air powered.

**Step 4**



- **Abrasive blasting** Excellent for removing paint, rust, or other hard imperfections from any surface, though less effective against softer coatings like rubberized paints or heavy grease (see photo).
- The downsides are that this method is messy and the equipment is expensive. You can use a 5hp/50gal air compressor (\$200 on eBay or Craigslist) with a small blasting gun, but more power and volume are better. A \$100 benchtop blasting cabinet will speed the process, keep you clean, and save you from having to sweep up abrasives from your driveway.
- Do not use actual sand, ever, for “sandblasting,” due to the risk of silicosis. Safe abrasives include glass beads (\$20 for 25lbs), aluminum oxide (more aggressive; \$50 for 25lbs), and ground walnut shells (gentler but slow; \$25 for 25lbs). While blasting, keep dust out of your lungs by wearing a real respirator with replaceable filters, not a disposable mask.
- Moisture in your compressed air will cause more rust later. A good cheap hack is to coil a long length of the hose through a

trash can full of cold water and install a water trap at the downstream end.

- Filter your abrasive medium thoroughly for reuse with a good sieve, or a series of 2 with decreasing mesh size. Paint, grease balls, or other impurities recycling through your gun will quickly lead to poor performance and require gun disassembly.

- **Soda blasting** This newer variant on abrasive blasting uses water-soluble baking soda. Soda is amazing for paint removal and for fragile materials like brass, copper, aluminum, and glass, but not so good with rust. Its solubility lets you blast pieces and clean them up easily in place, without having to remove them from engines or other locations where loose grit would cause problems.

- Soda blasting requires specialized equipment, but prices (without the compressor) have fallen below \$300.



## Step 5 — Use chemical methods.

- **“Homebrew” acids** Vinegar, lemon juice, or cola can remove light surface rust.
  - These won't work on heavy rust or paint. Stronger acids do the job better, with no sugary mess to clean up later.
- **Paint remover** Removes paint (duh) but not rust or corrosion. The best choice for painted, unrusted parts, since it won't affect the underlying metal.
  - Less effective on powder coats; for these, try multiple thick applications.
- **Alkaline rust removal (aka dip tanks or caustic dips)** *Not recommended.* This process involves sodium hydroxide (lye) and chelating agent solutions that are heated to near-boiling temperatures. It produces nasty toxic vapors and waste, and unless you have the right mix of chemicals, temperature, and experience, it's not as effective as the electrolytic method later in the project.

## Step 6



- **Phosphoric acid and naval jelly**  
Works alone to remove light surface rust or as a secondary stage following mechanical treatments.
- Heavy rust requires high concentrations of acid and long immersion, which still might not work on rust that has bloomed or turned to scale. With lighter rust, spray the acid and let it sit for 30 minutes, covered with cling wrap to prevent drying. For faster results, the object should be warm.
- Phosphoric acid is very effective as a secondary prep after mechanical treatment. It gets into miniscule cracks (especially on cast iron) and cleans out the bits of oxidation that even abrasive blasting can miss.
- Auto parts stores carry phosphoric acid and zinc preps for car body painting (e.g., POR-15 Metal-Ready), which seal the metal surface with zinc phosphate. Naval jelly, which can't be sprayed, is strong phosphoric acid in a thick medium to keep it in place.

## Step 7 — Use the electrochemical method by building your own electrolytic conversion tank.



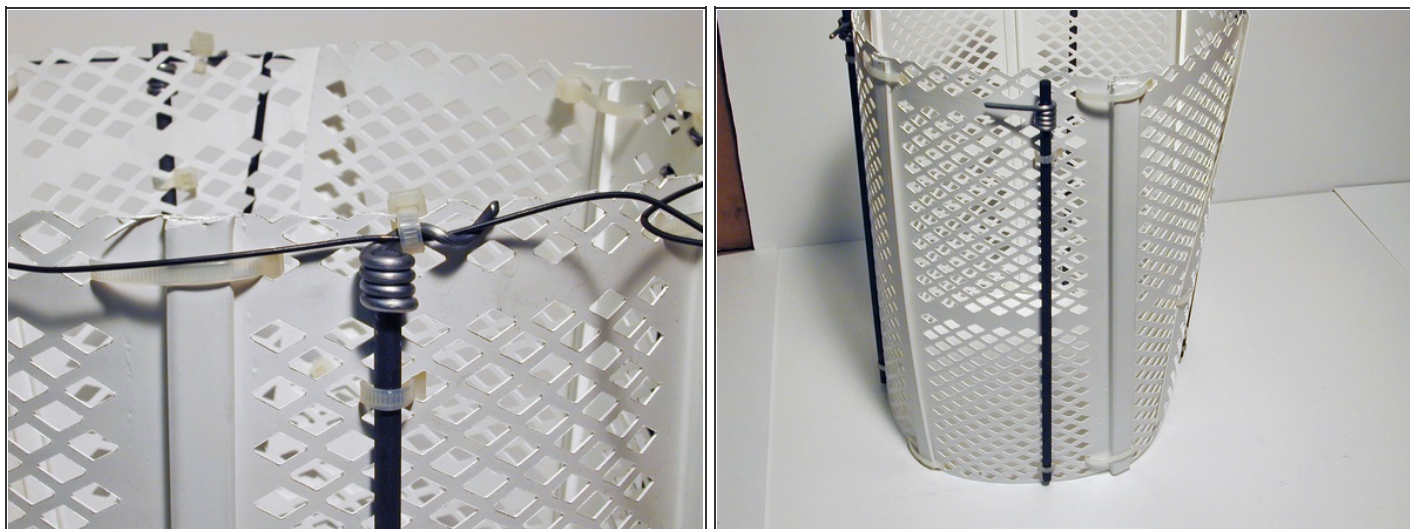
- This is a surprisingly simple way to remove heavy rust using DC electricity, a tank of sodium carbonate solution, and some sacrificial anode rods. After several hours of bubbling, the rust loosens or falls away.
- I've used it on mechanisms so corroded that you couldn't even make out their outlines, and after treatment the individual parts were easily disassembled with hand tools. You can even run electrolytic conversion on painted rusty surfaces, although it takes longer. (See Resources in the conclusion section.)
- With other homebrew electrolytic tanks I've seen, the objects just hang from a board in a 5-gallon bucket. I like my setup better because it uses plastic mesh to prevent short circuits between the anodes and the object being treated, and it all packs away neatly in the bucket.


## Step 8 — Install the mesh ring.



- Cut the ends off each gutter shield to make 6 pieces that just fit inside the bucket.
- Use zip ties to connect the pieces together into a ring that lines the inside of the bucket, with the factory-cut ends against the bottom.
- If your bucket is tapered, overlap the pieces to follow the taper. Trim the top portion of the mesh if needed to let the lid fit snugly.

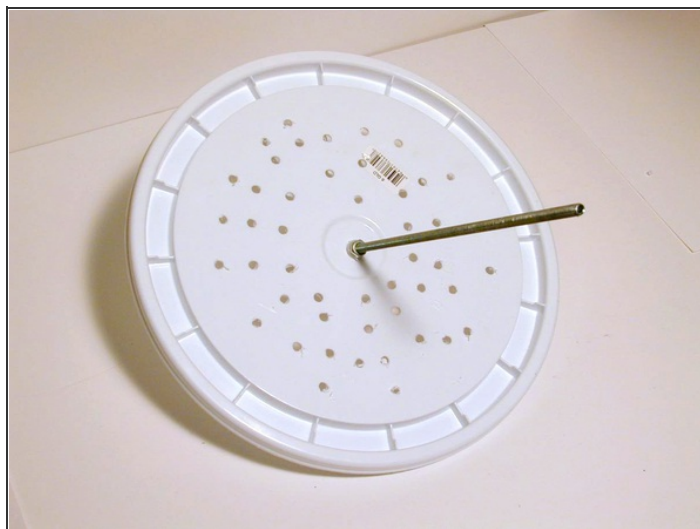
## Step 9 — Connect the rods.



- Wind and zip-tie a length of steel wire around the top of the mesh ring, connecting it to 4 anodes hanging down outside the mesh, one at each compass point.
- I used 4 because the process works in a “line of sight” manner between the anodes and the object’s surface. 
- With steel anodes, you can just tightly wrap the wire around the rod ends directly. I used carbon rods, which can shatter, so I attached them to the wire with small coils of softer tin solder.
- Zip-tie the anodes to the mesh.
- Finally, drill a hole in the lip of the bucket for the 2 ends of the steel conductor wire to pass through.

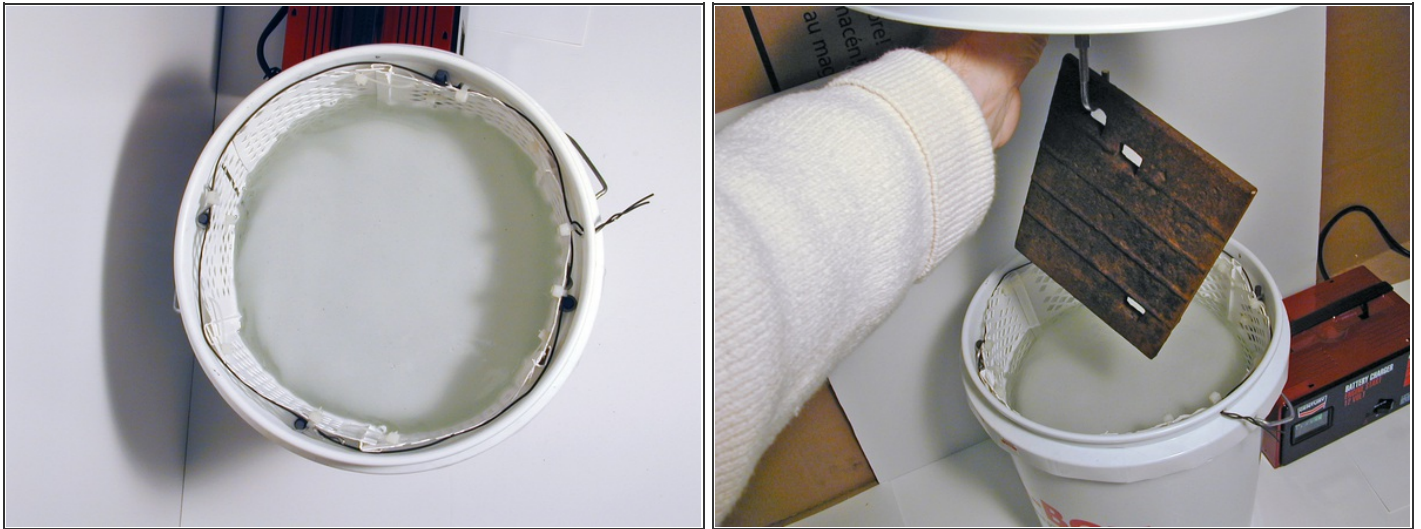


## Step 10 — Modify the lid.



- Drill a hole through the center of the lid and insert the threaded rod. Secure it with the washer and nut above the lid, and screw on the butt connector and ceiling hook at the bottom of the rod.
- Drill lots more holes in the lid for ventilation — the flammable oxygen and hydrogen byproducts need to escape during cooking!

## Step 11 — Put it together and zap some rust!



- Insert the mesh ring in the bucket. The addition of the anode rods should make it a snug fit. Pull the conductor wires through the hole in the lip of the bucket. Construction is complete.
- Set up an area with good ventilation. Fill the bucket with hot water to a level about 2" below the conductor wire. Add sodium carbonate, 1Tbsp per gallon of water. Stir.
- Put your rusty object on the hook, and adjust the nut so that the object and hook are completely submerged when you put on the lid.
- Connect the red (+) battery charger connection to the anode wires sticking out of the side of the bucket, and connect the black (–) cable to the threaded rod in the lid.
- After about 20 seconds, lift the lid a bit and sneak a peek at the object. You should see some very small bubbles forming on the surface. If not, check your connections. You may need to scuff the rust where the object touches the hook.
- Depending on the amperage of your DC supply, a full treatment may take up to 1 day or so, but you can't damage an item by leaving it in too long.

## Step 12





- Remove the object and dry it. The visible scale and surface rust will have been converted to a black powder that can be removed with a wire brush, wire wheel, or light abrasive blasting. This oxide dust doesn't cling to the metal like rust.
- Treat the object with a phosphoric acid and zinc prep solution. The acid removes any flash rust left by the bath, and the zinc protects against future rust and adheres well to primer. Dry, prime, and paint or clear-coat the object as soon as possible.
- Before painting or coating, mask off any gear shafts, keyways, or other high-tolerance fittings, and swab gear faces and other working surfaces with oil so you can wipe the paint off later. A metal detailing finish can preserve the metallic look, and for antiquing and other effects, miniatures catalogs carry a spectrum of paints for die-cast figurines.
- Before applying a clear coat, it's very important to remove all oils and other potentially corrosive materials. Brass, copper, and smooth cast iron are particularly sensitive to the acids in finger oils, and you don't want to have a fingerprint showing up months later! Wearing plastic gloves in a well-ventilated area, apply acetone

or another thin evaporative mineral spirit.

- You can coat with Rust-Oleum spray, or try POR-15 Glisten PC for more durability. For enclosed gears and mechanisms where dust isn't a problem, you can also coat parts with way oil, a heavyweight oil used to grease machine tools.

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### Hints and Notes

The electrolytic bath is basic (caustic), like lye, so wear goggles and rubber gloves and keep a bucket of water or a hose nearby in case you spill or splash some on yourself. Alligator clip cables work well for suspending small parts like nuts and bolts from the hook. Painted rusty objects can take much longer because paint impedes electricity. For better results, scratch up the paint first, or use a paint remover before treatment. Ordinarily, you can dispose of the used bath liquid down the drain. But if you removed lead paint or you suspect that heavy metals (chrome in particular) have leached from your items, let the water evaporate to form a sludge (not a dust!) and bring it to a local toxic materials processor.

### Resources

Metals Handbook, Volume 5: Surface Cleaning, Finishing, and Coating, American Society for Metals, various editions and years — an excellent general reference [Wolfgang Jordan's Small Tool Museum](#) explains the chemistry of electrolytic conversion. [Bill's Antique Gas Engines](#) explains the chemistry of electrolytic conversion.

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